Refurbishment and
Museum Installation

for the

LUNAR EXCURSION MODULE SIMULATOR

NATIONAL HISTORIC LANDMARK

National Aeronautics and Space Administration
Langley Research Center
Hampton, Virginia

# DESCRIPTION OF

# THE UNDERTAKING

Attachment B
13 Pages

ATTACHMENT B

DESCRIPTION OF THE UNDERTAKING

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## RESTORATION REMINDERS

**RAY GOODMAN**
**EXHIBITS CURATOR**
**VIRGINIA AIR AND SPACE CENTER**

The Lunar Excursion Module Simulator (LEMS) is a unique artifact of historic significance. As such, it should be treated with the greatest care at all times. Any replacement parts must match, as closely as possible, the design and appearance of the original parts.

Documentation must be provided for any replacement part or for any alteration to an existing structure. This documentation is required so that the historical accuracy of the artifact can be maintained. Removal of old paint, stains or other minor blemishes to the surface appearance need not be recorded.

Damage caused to any part during the restoration process must also be documented with text and photographs. It is better to leave any minor damage that is found in its present condition.

At all times, keep in mind that you are working with an unique artifact. There is no possibility of replacement. The LEMS will be exhibited in the Virginia Air and Space Center to share with the public the contributions made by the NASA Langley Research Center in the Apollo program. Also, the exhibit will stand as a reminder of the work done by the students of the New Horizons Technical Center in the restoration of this national historic landmark.

# LUNAR EXCURSION MODULE SIMULATOR PROJECT OVERVIEW

## LEMS Background

The Lunar Excursion Module Simulator (LEMS) was a manned rocket-powered vehicle used to familiarize the Apollo astronauts with the handling characteristics of a lunar-landing type vehicle. In its earlier test period, the LEMS featured a helicopter crew cabin atop the lunar landing module which the test pilot sat down in and operated the vehicle. Later, the helicopter crew cabin was replaced with a stand-up rectangular cabin. This cabin design was more efficient for controlling maneuvers and for better visual viewing by the pilot.

In addition to designing and fabricating the LEMS, Langley also constructed the Lunar Landing Research Facility (LLRF). The LLRF, an unique and imposing erector-set structure, provided the capability to perform simulated lunar landings with the LEMS. This overhead structure, usually called the gantry, gave support to the vehicle with a force equal to five-sixths its weight. The remaining one-sixth "g," or one-sixth the weight of the vehicle, was supplied by the vehicle's own rockets just as on the lunar surface.

An exact reproduction of a portion of the lunar surface was constructed on the concrete pad under the gantry. Dark shadows around the "craters" were applied using a portable paint sprayer. Floodlights were erected at the proper angle to simulate lunar light and a black screen was installed at the far end of the gantry.

On July 20, 1969, as the Eagle was landing on the moon, Apollo astronaut Neil Armstrong reported, "I see my shadow," exactly as he had during the Langley tests. Armstrong returned to Langley following his historic flight and piloted the lunar module once more. He verified that it was a very valid simulation of the actual experience.

## LEMS Restoration Project

History, technology, and education come together in the restoration of the LEMS. In 1986, the LEMS was designated a national historic landmark. The artifact was transported to the New Horizons Technical Center (NHTC), Hampton, Virginia, for restoration in September 1989. The high school vocational students at the NHTC will restore the artifact for future placement in the Virginia Air and Space Center, Hampton, Virginia. The students will have a two-year time schedule to complete the restoration project.

## LEMS Future Plans

The LEMS will become an exhibit display in the Virginia Air and Space Center/Hampton Roads History Center. The Center is scheduled to open Spring 1992. The LEMS exhibit will illustrate the NASA LaRC contributions made to the early space program and to man's exploration in space. An exhibit sketch depicting the proposed set-up of the LEMS in the Air and Space Center is found under Virginia Air and Space Center section of the notebook.

## THE NASA LaRC/NHTC PARTNERSHIP

In response to President Reagan's "Partnership in Education," a concept which directly involved the government and the private sector with schools, NASA established an agency-wide Adopt-A-School Program.

In keeping with the Adopt-A-School Program, NASA Langley Research Center formally adopted the Governor's Magnet School for Science and Technology, located at 520 Butler Farm Rd. in Hampton, on December 20, 1984.

Known officially as the New Horizons Technical Center (NHTC), this school serves students from six Peninsula-area school districts. Its science and technology focus made it an ideal match for a basic research, high technology center like Langley.

In September 1985, the magnet school received its first class of students. During the 1985-86 academic year, over one-third of the students were placed in a mentorship experience with either a Langley scientist or engineer.

Since 1985, Langley has provided a mentorship site for over 80 students enrolled in the magnet school component. In addition, the mentorship opportunity was expanded in 1987 to encompass the NHTC vocational technical programs and teachers.

The history of the NASA LaRC/NHTC partnership extends beyond the mentorships. The NHTC site has been utilized and the NHTC staff have supported both student (i.e., TOPS) and educator (i.e., NEWEST) programs developed by Langley's educational specialists.

Further expansion to the partnership is underway with the restoration project of the Lunar Excursion Module Simulator (LEMS) by selected vocational students. The LEMS is a historic artifact which was designed and fabricated at NASA Langley. It was used to train the Apollo astronauts for landing on the moon. As LaRC contributed to the history of space, the NHTC will contribute to the preservation of a historic space vehicle.

The restoration plans include that the vehicle be placed as one of the major exhibits in the new Virginia Air and Space Center and Hampton Road's History Center, which is scheduled to be completed by 1992.

The partnership is one which both parties contribute to and both parties receive from. It is an exemplary partnership which has earn state, national, and international recognitions. The following awards have been received:

- 1987 Best Small District Partnership Program, from the Association of School Business Officials International;
- 1988 Partnerships in Education Journal National Partnership Award, from the Partnerships in Education National Association; and
- 1989 Check Excellence Award for Vocational Education in Virginia, from the Virginia Council on Vocational Education.

MEMORANDUM OF AGREEMENT

BETWEEN

NASA LANGLEY RESEARCH CENTER

AND

THE NEW HORIZONS TECHNICAL CENTER

The National Aeronautics and Space Administration, Langley Research Center (hereinafter referred to as NASA/LaRC), acting under the authority of the National Aeronautics and Space Act of 1958, as amended, and the New Horizons Technical Center (hereinafter referred to as NHTC) jointly execute this Memorandum of Agreement (MOA) in order to facilitate the mutually beneficial refurbishment of the Lunar Excursion Module (LEM).

1.0 BACKGROUND

In response to the "Partnerships in Education" concept promoted by the Reagan Administration, NASA established an agency-wide Adopt-A-School Program. In 1984, NASA/LaRC implemented that program by formally adopting the Governor's Magnet School for Science and Technology, which is now called the New Horizons Technical Center. NHTC is a regional vocational center which services six (6) school districts on the Virginia Peninsula.

The LEM has been designated a National Historic Landmark and will eventually be moved to the Virginia Air and Space Center, a move which is expected to occur by July 1991.

2.0 PURPOSE

The objectives of this MOA are to refurbish the LEM and, in the course of accomplishing that goal, to provide training for NHTC students.

3.0 RESPONSIBILITIES OF THE PARTIES

3.1 NASA/LaRC agrees to use its best efforts to:

3.1.1 Disassemble the LEM and transport it to NHTC;

3.1.2 Provide technical advice through an advisory group which will oversee the effort performed pursuant to this MOA; and

3.1.3 Provide the required parts and supplies to NHTC.

3.2 NHTC agrees to use its best efforts to:

3.2.1 Provide the students necessary to accomplish the refurbishment of the LEM pursuant to technical advice from the NASA/LaRC Advisory Group;

3.2.2 Notify NASA/LaRC in a timely manner of the need for parts and supplies required for this effort; and

3.2.3 Clean up the LEM's exterior; refurbish, identify and label the LEM's visible components; identify and display the name of each astronaut who flew in the LEM, including the time of the flight; and perform any other task necessary to accomplish the purpose of this MOA.

4.0 PERIOD OF AGREEMENT

This MOA shall remain in effect for a period of two (2) years from the latest date upon which both parties have executed same.

5.0 COSTS AND FUNDING

There will be no transfer of funds or other financial obligation between NASA/LaRC and NHTC in connection with this MOA. NASA's performance of this MOA is subject to the availability of NASA's appropriation therefor, and further, nothing expressed herein commits the United States Congress to appropriate funds therefor. However, NASA/LaRC agrees to use its best efforts to obtain the necessary funding.

6.0 LIABILITY

6.1 NASA and NHTC agree that with respect to injury, death or damage to persons or property involved in operations undertaken pursuant to this MOA, neither NASA nor NHTC shall make any claim with respect to injury or death of its own or its contractors' or its subcontractors' employees or damage to its own or its contractors' or subcontractor's property caused by activities arising out of or connected with this project, whether such injury, death or damage arises through negligence or otherwise.

6.2 NHTC shall not make any claim against the United States Government (or its contractors or subcontractors) for damage or other relief for any delay (including a deferral, suspension or postponement) in the provision of any service under

this MOA or for the nonperformance or improper performance of such services, including, but not limited to, the performance by the United States Government or by the United States Government's contractors or subcontractors. In any event the United States Government's liability to NHTC arising out of this MOA, whether or not arising as result of an alleged breach of this MOA, shall be limited to direct damages only and shall not include any loss of revenue or profits or other indirect or consequential damages.

7.0 INDEPENDENT RELATIONSHIP

This MOA is not intended to create, constitute, give the effect of or otherwise recognize a joint venture, partnership, agency or formal business organization of any kind, and the rights and obligations of the parties hereto shall be only those expressly set forth herein.

8.0 UNITED STATES GOVERNMENT OFFICIALS NOT TO BENEFIT

No member of or delegate to the United States Congress, or resident commissioner, shall be admitted to any share or part of this MOA, or to any benefit that might arise therefrom, but this provision shall not be construed to extend to this MOA if made with a corporation for its general benefit.

9.0 MODIFICATION AND TERMINATION

This MOA sets forth the entire and complete agreement between NASA/LaRC and NHTC and may be modified only by written mutual agreement. This MOA may be terminated prior to its

expiration by either party upon written notice to the other party communicated not less than sixty (60) days in advance.

Richard H. Petersen

RICHARD H. PETERSEN
DIRECTOR
NASA LANGLEY RESEARCH CENTER

9/25/89
DATE

Ralph W. Johnson

DR. RALPH JOHNSON
DIRECTOR
NEW HORIZONS TECHNICAL CENTER

9-26-89
DATE

## CERTIFICATION

The Lunar Excursion Module Simulator (LEMS) artifact has been inspected by the NASA Langley Safety Office. The artifact's propulsion system has been purged of all hazardous materials. There should be no hazard from opening any portion of the engine/propellant subassembly. The structure of the artifact, however, must not be required to carry any loads in excess of normal manloading. Use of scaffolding, work platforms and personnel protection shall comply with Virginia Occupational Safety and Health regulations.

V. William Wessel
Head, Safety Engineering Branch

DRAFT

# NASA/NHTC LEMS TASK LIST

TASK

1 REMOVE AND REFURBISH CAB INSTRUMENTATION PANNEL

2.REPLACE AND CONNECT ATTITUDE SYSTEM CONTROL WIRE

3.REMOVE AND INSTALL CAB PLEXIGLASS

4.REMOVE CAB CAMERA AND REFURBISH

5.POLISH CAB AREA AND REMOVE OXYGEN TANK/WATER COOLER

6.REFURBISH LANDER LEGS (remove- spring,micro/switch,& wire)

7.REMOVE AND REPLACE MAIN MOTOR CONTROL VALVE

8.REPLACE AND INSTALL SOLENOID AND OPERATIONAL VALVES

9.MANUFACTURE AND INSTALL 16 ATTITUDE SOLENOIDS

10.REMOVE AND REPLACE LATCHES

11.REMOVE EXCESS TAPE FOR WIRING PREPARATION

12.FABRICATE AND INSTALL MOTOR CONTROL CENTER

13.FABRICATE NEW NAME PLATE AND INSTALL

REQUIREMENTS FOR THE REFURBISHMENT OF THE
LUNAR LANDING EXCURSION MODEL SIMULATOR (LEMS)

1. CONTROL CAB

Clean interior and exterior of the aluminum control cab. Replace plexiglass in windows. Remove front camera mount, rear oxygen supply system and suit cooling water tank. Refurbish systems replacing deteriorated and/or missing hoses and tubing. Buff cab to original condition. Replace units on cab. Clean and renew instrument and control systems and panels for cosmetic appearance only.

2. INSTRUMENT AND CONTROL JUNCTION BOXES

Clean and refurbish junction boxes. Replace all rust deteriorated box latches. Repaint computer box and refinish all other units.

3. ATTITUDE CONTROL SYSTEM

Renew and clean all attitude control rocket motors, solenoid valves and piping systems for cosmetic exterior appearance only.

4. MAIN MOTORS AND HYDROGEN PEROXIDE SYSTEM

Clean and renew piping system. Clean and burnish stainless steel fuel tanks. Clean and buff titanium gaseous nitrogen spheres. Renew necessary piping and valves for cosmetic appearance.

5. ELECTRICAL AND ELECTRONIC

Inspect and refurbish damaged and/or missing wiring and connectors to restore to original cosmetic configuration. Install computers for appearance (not functional).

6. LANDING GEAR SYSTEM

Clean, refurbish, and reinstall landing gear struts and pads. Paint steel surfaces with aluminum paint. Renew shock absorber units.

7. VEHICLE STRUCTURE

Clean and repaint the steel vehicles frame and structure to reflect original configuration. Apply necessary decals. Identify and label the LEMS visible components. Display the name of each astronaut who flew in the LEM and perform any other task necessary to accomplish the memorandum of understanding prior to use of the LEMS as an exhibit in the Virginia Air and Space Museum in Hampton, Virginia.

8. FASTENERS

Replace or renew fasteners, as required, to conform to original condition.